

HETERORHABDITIS SPP.: NEMATODE PARASITES OF INSECTS.

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In 1976, Poinar (5) found a nematode in the pupa of the Australian budworm, Heliothis punctigera Wallengren collected in Australia. He named the nematode Heterorhabditis bacteriophora; two additional species have been described: H. heliothidis (Khan, Brooks and Hirschmann 1976) Poinar 1979 (6), and H. megidis Poinar et al. 1987 (7).

DISTRIBUTION: One or more species of Heterorhabditis has been reported in Argentina, Australia, China, Cuba, France, Italy, Lithuania, New Zealand, Poland, the U.S.A. and the U.S.S.R. (2,3,4,6). In Florida, a preliminary survey of insect-parasitic nematodes has revealed Heterorhabditis spp. in four counties: Escambia, Orange, Pinellas, and St. Johns.

BIOLOGY: The development of all known species of Heterorhabditis is similar (6,8). The infective juvenile (third stage) carries a bacterium in the anterior part of the lumen of the intestine. When the juvenile finds a susceptible host, it enters through the mouth, spiracles, anus, or directly through the cuticle. Usually many nematodes enter the same insect. Two hours after exposure infective juveniles can be found in the hemocoel of the host insect where they release the bacteria. The bacteria multiply rapidly and kill the host in 24 to 48 hours. Nematode infection induces color change of the insect body (especially lepidopterans) from their normal color to light red, then to dark-red (Fig. 1). In the host, the juveniles feed on the bacteria, and develop into adults in about 3 days after the death of the host insect. These first generation adults (Fig. 2A, B) are hermaphroditic with typical female characteristics. They lay some eggs in the body cavity of the host, but many eggs remain in their bodies. Juveniles that emerge from these eggs develop into second-generation adults of both sexes (gonochoric). Second generation females (Fig. 2C) are smaller than the first generation females with hermaphroditic gonads. After mating these second generation females produce eggs which develop into infective juveniles (Fig. 2D). These juveniles emerge from the host, enter the environment and search for a new host.

ASSOCIATED BACTERIUM: The bacterium Xenorhabdus luminescens Thomas and Poinar 1979 is carried by the infective stage of Heterorhabditis juveniles. The bacterium, some species of which glow in the dark, has a primary and a secondary form (1). The primary form has antibiotic activity which inhibits the growth of different micro-organisms and is used for in vitro production of the nematode. The secondary form does not have antibiotic activity and

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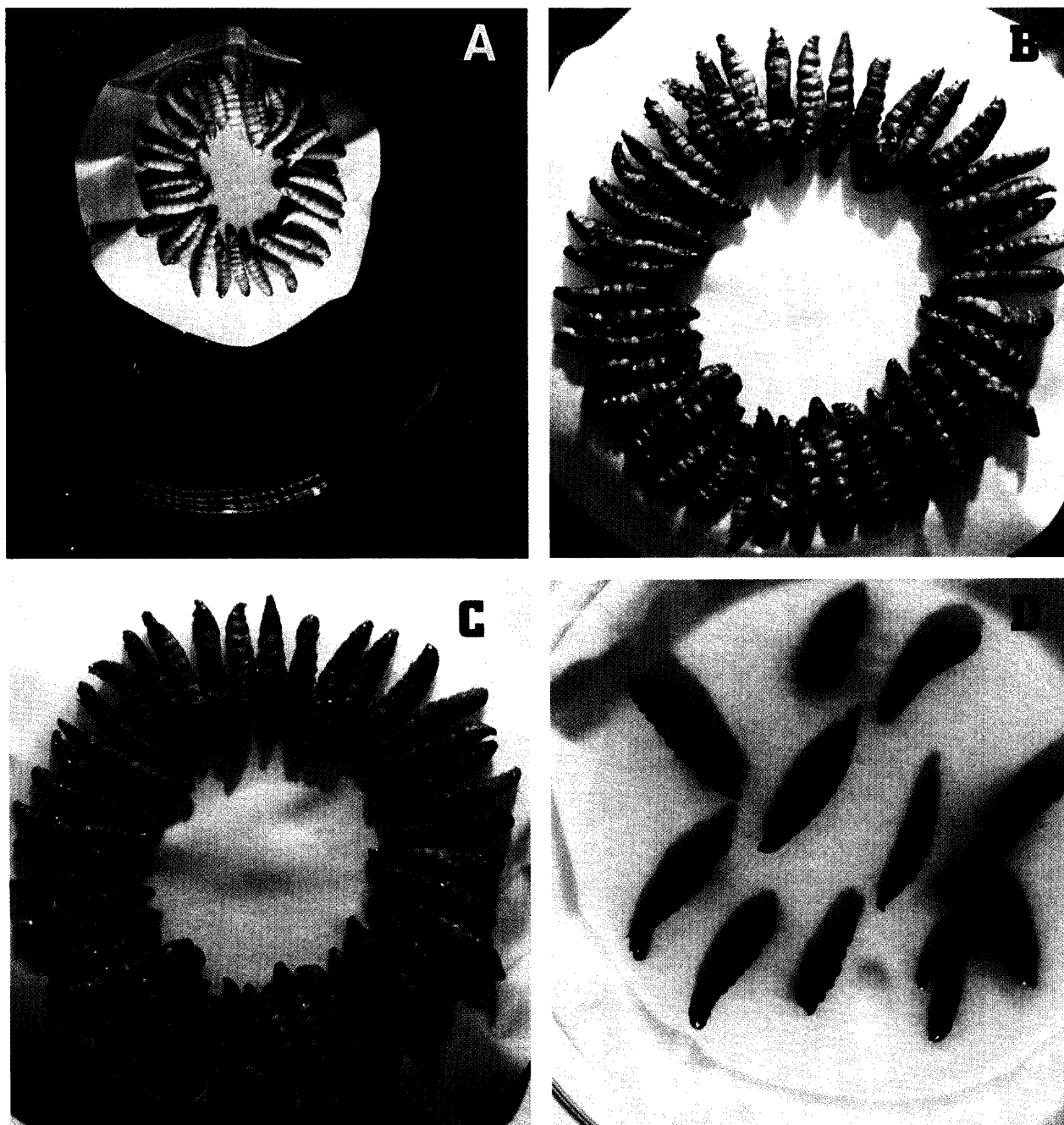


Fig. 1. Wax moth larvae. A) The white to cream color displayed here is the natural color of the larvae and the color of those infected with Steinernema spp. B-D) The color changes from cream to light red to dark red when infected by Heterorhabditis spp.

is less effective than the primary form for in vitro production. Both forms are pathogenic to insect hosts.

HOST RANGE: Heterorhabditis spp. have been reported to infect and kill insects in the following orders and families:

Order Coleoptera: weevils (Curculionidae), scarab beetles (Scarabaeidae), bark beetles (Scolytidae).

Order Diptera: mosquitoes (Culicidae).

Order Hymenoptera: braconid wasps (Braconidae).

Order Lepidoptera: tiger moths (Arctiidae), diopiid moths (Diopitidae), wax moths (Galleriidae) tent caterpillar moths (Lasiocampidae), tussock moths (Liparidae), noctuids and underwing moths (Noctuidae), notodontid moths (Notodontidae), pyralid and grass moths (Pyralidae), sphinx moths (Sphingidae), leafrolling moths (Tortricidae), white, sulphur, and orangetip butterflies (Pieridae).

Order Orthoptera: small cockroaches (Blattellidae).

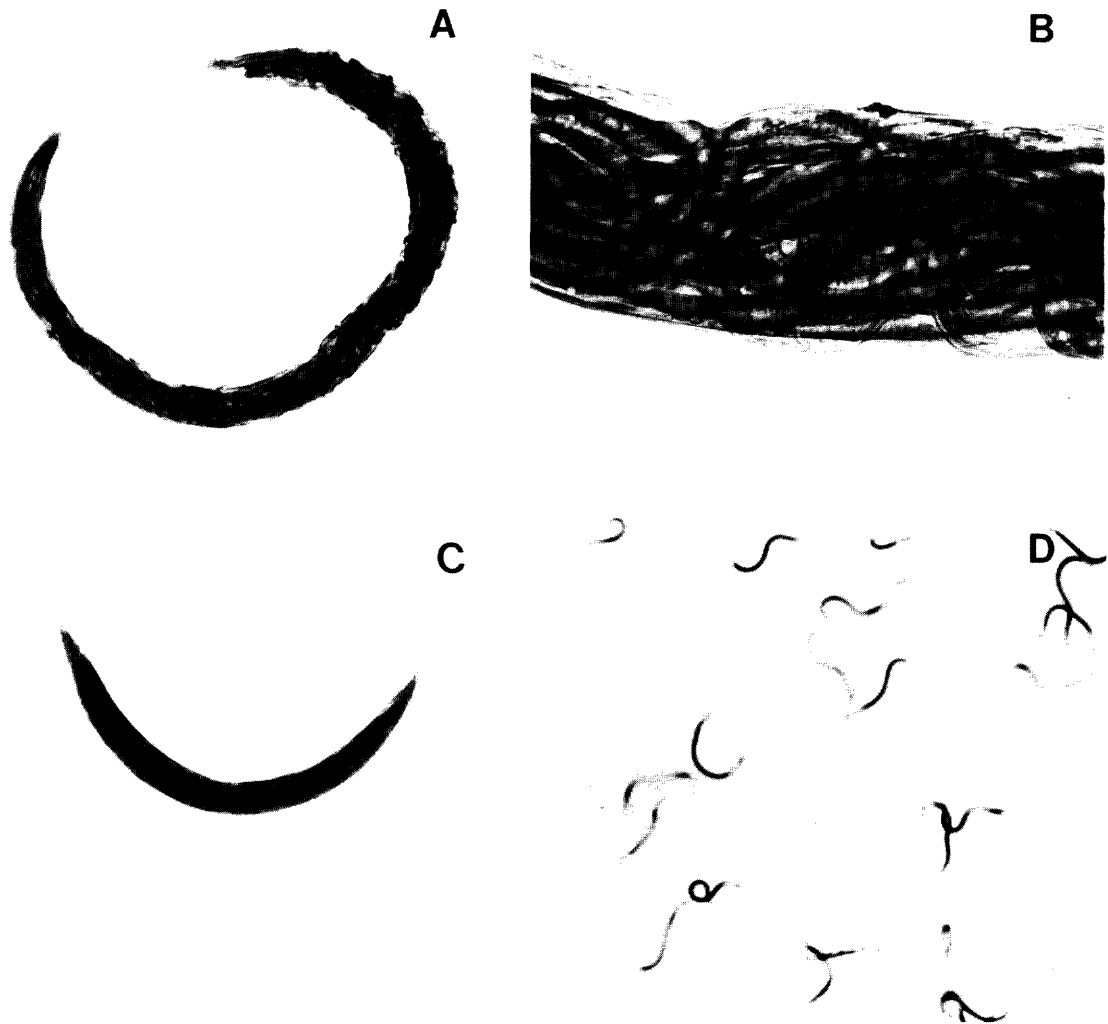


Fig. 2. Some life stages of Heterorhabditis spp. A) Female with hermaphroditic gonads, (first-generation) containing juveniles in its body. B) Enlargement of a portion of A. C) Female (second-generation) gonochoric containing juveniles in its body. D) Third stage juvenile which is the infective stage.

POTENTIAL FOR INSECT CONTROL: For experimental purposes, the nematode can be reared on wax moth larvae, Galleria mellonella, with each larva producing up to 350,000 infective juveniles. Also, the nematode can be produced in mass commercially on artificial media.

Experiments have shown that Heterorhabditis spp. have good potential for controlling certain insects because of their host seeking ability (especially in tunnels made by stem borers), their high infectivity and the fact that the first generation hermaphrodites can colonize from a single individual.

For the insects that have been studied, it was found that Heterorhabditis sp. have the potential to infect all life stages of the insect except the eggs.

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